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SOME OBSERVATIONS ON COAL-MINE HAULAGE HAZARDS

BY

H. E. SANFORD

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SOME OBSERVATIONS ON COAL-MINE HAULAGE HAZARDS[1]

By H. E. Sanford[2]

INTRODUCTION

Of the occupations in and about coal mines, those of the haulage crews are among the most hazardous. Statistics indicate that the second largest number of fatalities about coal mines occurs during haulage operations and through the use or misuse of haulage equipment. Despite the fact that relatively few coal-mine employees are engaged continuously at haulage operations, approximately 20 percent of all coal-mine fatalities are attributable to haulage.

Most of the hazards in haulage operations could be very greatly reduced if more serious consideration were given to the problems of the haulage crews and if sincere efforts were made to reduce the hazards. Underground haulage is similar in many respects to railroading; yet, railroading is now considered one of the safest of occupations, a distinction that has been attained only by honest effort and whole-hearted cooperation on the part of all concerned. Underground haulage is also similar to street and highway operation and has in it some of the difficulties encountered in the reduction of traffic accidents the seriousness of which has not by any means been controlled as yet, notwithstanding the fact that much effort has been expended through a multiplicity of laws, ordinance regulation, etc., as well as by thousands of enforcement agencies and officers.

The men working on the locomotives are among the most important members of a coal-mine organization; without skilled haulage employees, the production of coal would be greatly retarded. Their jobs, particularly the job as brakeman, require physical endurance, agility, and mental and physical alertness; in thin coal beds, especially where the roof is not brushed and the coal is loaded into mine cars by hand, the need for these qualifications is greatly increased.

It is not the intention to attempt a discussion of all the hazards incident to coal-mine haulage, but a few of the more common sources of danger are discussed briefly and suggestions made for their correction.

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[1] The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from Bureau of Mines Information Circular 7467."

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MAINTENANCE OF HAULAGE EQUIPMENT

One prolific source of accidents, and an expensive oversight from an efficiency standpoint, is the failure in many instances to maintain haulage equipment in good operating condition. Locomotive wheels are permitted to become "double-flanged" to the detriment of rails, track switches, and bonds. When the locomotive is operated on larger rails than those upon which the wheels were worn, the tractive efficiency of the locomotive is greatly reduced, and wear of the rails is greatly accelerated. The electric wiring of the locomotives is permitted to become saturated with oil, which results in frequent "burn-outs." Resistances are bridged with wires until the locomotive jumps dangerously when the power is turned on. Brake shoes are worn until they are ineffective and the controller or reverse must be used as a brake. Trailing cables are used long after they should have been replaced because of frayed insulation and other deficiencies.

Mine cars with holes in the sides and floor, leaky endgates, and flattened wheels result in so much coal spillage that men must be employed constantly to keep the roadways passable. Excessive spillage of coal along haulage roads is also caused by careless methods of loading of coal at or near the faces, by high-speed haulage, or by recklessness or carelessness of haulage employees in bumping cars by sudden starting or stopping or otherwise. Even when the tracks are cleaned frequently, some of the coal is ground to fine dust, which is subsequently deposited on the roof, floor, and ribs, resulting in an increase in the dust-explosion hazard; here again carelessness assists in stirring the dust into the air because of excessive haulage speed, etc.

Frequent inspections of the haulage equipment and prompt corrective action when defects are found are very likely to pay handsomely for themselves by helping to insure continuous, trouble-free operation of the equipment and by helping to reduce the expense of cleaning the roadways; moreover, the accident rate among the haulage employees, which is of even greater importance, will almost certainly be reduced.

POOR TRACK CONTRIBUTES TO INJURIES

Probably the greatest reason why derailments occur rarely on railroads is the fact that the railroad companies try to maintain their tracks in first-class condition. There is no good reason why derailments should occur much more frequently in coal mines than on railroads. Mine tracks should be constructed with ties and rails large enough to carry, without undue wear, the weight of the equipment that is used upon them. The rails should be fastened together securely, and the track ties, particularly those along the main haulageways, should be set in good-grade ballast. The first cost of such an installation may seem excessive, but exhaustive time-study surveys on the subject have proved conclusively that, in general, the ultimate benefits more than justify the somewhat higher original expenditure.

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In many mines the main-line tracks are in fair condition, but the tracks along the secondary haulageways and room entries, and in the rooms are poorly alined, poorly drained, and poorly ballasted. Often switches are not complete with switch throws and bridle bars. Rail joints are not connected securely with fishplates and bolts, or otherwise ties are spaced too far apart; hence the rails are not fastened securely to the ties. In such mines, because of derailments, the main-line haulage is often compelled to wait at the sidetracks for the coal assembled by the gathering crews.

With well-maintained tracks, the gathering-motor crews can serve a maximum number of coal loaders and serve them more safely and efficiently than if the tracks are poorly maintained. In addition, excessive speeds are not required, and the locomotive crews are engaged continuously in productive work. One small derailment may not appear to affect the production of coal seriously, but when such derailments occur several times each shift, muct time and money are being wasted and accident occurrence is almost certain to increase. Moreover, coal loaders are idle while waiting for "empties;" trackmen are called away from other work to "patch up" the damage caused by the derailment; main-line haulage crews are compelled to wait at the sidetracks for coal, with a consequent delay at the tipple or shaft bottom; and employees are very likely to be injured as a result of derailments.

Poor track maintenance has a serious mental effect upon the haulage crews. Knowing that the delays caused by derailments may cause other workmen to be waiting, the haulage crew is likely to attempt to "make up" for the delay by overspeeding, introducing other hazards. Certainly, these men are not likely to be in a suitable frame of mind to perform their work safely and efficiently if they are compelled to devote a great part of their time to retracking derailed equipment, always a nerve-wracking and hazardous job.

ADEQUATE CLEARANCE A NECESSITY

One popular misconception of economy is evidenced in many coal mines by the lack of enough clearance over and alongside the haulage tracks, particularly along the secondary and room-entry haulageways. Generally, adequate overhead clearance is provided along the main haulageways where there is but little shifting and coupling of cars and where the brakemen are usually riding. Clearance in these places is provided usually to permit the use of larger locomotives, to reduce the grades, and to permit greater speeds; however, in the room entries in thin coal beds, where the brakeman is usually on foot, where most of the switching and coupling are done, and where most of the mining activities are conducted, the overhead clearance is often restricted, and the brakeman must have great agility and physical endurance if he does his work and survives without being injured. Large percentages of the fatal and nonfatal accidents attributed to haulage are due to the lack of clearance.

The clearance, both over and alongside the tracks, should be provided as the entries are developed. Four or five extra tons of coal each shift from each gathering crew may in many cases be obtainable if enough clearance is provided; if this can be done, it will more than offset the cost of brushing the roof along room-entry haulageways; it is extremely probable that increased overhead clearance will, in at least some cases, permit the haulage crew to haul more than a few extra tons per shift and do it more safely.

The gathering motorman in a thin coal bed where the roof has not been brushed and where he is often required to operate a locomotive that was designed for a thicker bed has a very difficult and dangerous job. He is at least partly folded up in the cab, sometimes with his head between his knees, because the controller case and the various switches occupy most of the available space. Often he cannot see across the top of the locomotive because of the low roof and cannot see around the side of it because of posts or rib so close to the track that his head is in danger if he attempted to do so. He therefore must depend largely upon signals sounded by the brakeman to operate the locomotive, a very unsafe procedure. Operation of a locomotive under such adverse conditions is decidedly hazardous, doubly so when the motorman or brakeman is not familiar with that particular section of the mine, a condition likely to occur relatively frequently.

When a locomotive is being operated through a trailing cable in low coal, the motorman often is unable to reach the trolley wire with the trailing-cable nip, especially when the wire is on the side opposite the motorman. If the trolley wire is on the side of the entry nearest the motorman, that motorman is in danger of becoming entangled by the cable if he fails to disengage the nip from the wire when he comes out of rooms. Many motormen have been killed or seriously injured in this manner.

Definite hazards are in effect when the trolley pole is knocked off the wire at a place where overhead clearance has not been provided. The locomotive must be brought to a complete stop before anything else can be done. Then, either the brakeman must crawl around the trip or between the cars and replace the pole on the wire, or the motorman must "wriggle" his way out of the cab, crawl around the locomotive and replace the pole, and crawl back and wriggle his way into the cab again. In any case, unnecessary hazards are encountered, and wasteful delay occurs. As a result of the delay, an ambitious motorman, in attempting to make up for the delay by overspeeding, introduces additional hazards.

A motorman has relatively little chance to escape being burned when operating a locomotive in a thin coal bed without sufficient overhead clearance if or when the controller or a switch in the cab catches on fire. Such instances are far from rare. Generally, his feet, legs, and knees are against the controller casing, because he has no other place to put them. Hence he cannot get out of the cab quickly and as a fire in the controller case burns through the casing within a few seconds, he is very likely to be burned, possibly fatally, as a consequence of inadequate overhead clearance.

It is desirable that adequate clearance be provided along both sides of all mine track, but where this is not practicable because of adverse natural conditions, clearance should be provided continuously along the side opposite the trolley wire.

Many brakemen and other employees are injured through failure to provide and maintain enough unobstructed clearance alongside the tracks. These men often are required to cross between standing cars and pass underneath unguarded trolley wire in their efforts to get from one end of a trip to the other, because of the fact that there is not a continuous traveling way on either side of the track. Where clearance is not provided, the brakeman must travel in the roadway ahead of a pushed trip; and, if he stumbles and falls, the results are almost sure to be fatal. When a derailment occurs at a place where the posts, ribs, or gobbed material is too near the track, a brakeman cannot retrack the equipment either safely or quickly; generally, he does not attempt to do so at such a place and signals the motorman to move the equipment to the nearest switch or place where he can work safely. As a result, the track over which the derailed equipment is dragged suffers further damage. On the other hand, if he attempts to retrack the equipment where the clearance is impaired, the brakeman is likely to suffer serious injuries or even death. In either instance, the efficiency of the haulage operations is greatly reduced by the lack of sufficient clearance.

Providing adequate overhead clearance and maintaining ample, unobstructed side clearance along all haulageways should be considered economic necessities, even if the safety of the employees is not taken into account. Trackmen, timbermen, supervisors, and others whose duties require them to travel extensively through the mine can perform more and better work, and fewer "company men" are needed for at least some types of work.

EXTENT OF MOTOR SECTIONS

The extent of the area over which a gathering-motor crew operates and the number of men served are important factors in the number of haulage accidents.

Unnecessary travel over long distances is a waste of time and money, and a well-planned mine lay-out should ordinarily permit the concentration of a reasonable number of miners within a comparatively small area. With a relatively small area for a haulage unit, there is a minimum amount of track to require the attention of maintenance men, less trolley wire must be maintained, ventilating problems are likely to be simplified, and the work can be supervised closely, with relatively few supervisors. All of these factors are related closely to safety. A widespread "motor section" and a large number of miners to be served may bring about overspeeding by the motor crew. Miners complain of having to wait too long for "empties;" and the superviser, in his efforts to satisfy the miners and to increase production, is likely to put "pressure" on the gathering crew. As a result, the gathering crew may respond with more speed than the condition of the track and haulage equipment, restricted space along haulageways, and recognized safety practices permit.

A motor section should not be larger than can be handled safely and efficiently by the haulage crew. No economy results in adding five or six miners to a section where the haulage crew is already doing its utmost. The total number of cars loaded during a shift is not likely to be increased;

in fact, it is more likely to be decreased by derailments caused by the longer trips and by the attempts of the haulage crew to increase the speed of their operations. Long trips near the face regions are not conducive to safety or efficiency. The comparatively light locomotives generally used for gathering purposes are likely to be overloaded to their detriment, and the long trips may not be kept under control at all times. The gathering crew should not be required to handle more cars than can be stopped within a short distance, and it should not attempt to pull more cars than can be pulled without jerking. Such jerking of cars imposes much more strain on the couplings than steady pulls, and broken couplings are responsible for many haulage accidents. In addition, jerking of loaded cars causes much spillage of coal on haulageways.

PROVIDE A SAFE PLACE FOR THE BRAKEMAN TO RIDE

Most State laws and company regulations prohibit brakemen from riding on the front end of a locomotive. This is a sound safety precaution, but only a few locomotives or trips are provided with safe places for the brakemen to use when riding.

Some locomotives have a step on the side opposite the trolley wire, and many of the steps are made wide enough and long enough to permit the brakeman to stand or kneel in comfort while facing in the direction of travel. While this method has some advantages, it also has some disadvantages. If such a side-step is provided, the clearance space alongside the track is fairly likely to be maintained clean and of ample width, but even if the step is wide enough and long enough, the brakeman has relatively little freedom of movement, expecially where the roof is not brushed; and he is in a particularly exposed position in case of a derailment along a closely timbered haulageway. There is also the disadvantage in thin coal beds of having the brakeman kneel on the side-step with his face near the locomotive wheels, where his eyes are endangered by the flying particles of sand and where he is exposed to an atmosphere that is often polluted with sand dust. Doubtless many of the cases of so-called miners' asthma and tuberculosis are, in reality, silicosis caused by breathing such dust.

Another system, and a far better one, provides a deck or cab for the brakeman on the end of the locomotive opposite the motorman. With such a cab or deck there is far less likelihood that the brakeman will fall off or be crushed between the locomotive and posts, rib, gobbed material, or cars in case of a derailment.

Some of the newer types of locomotives have been equipped with such cabs by the manufacturers, but only a few of the older ones have such space available to the brakemen; generally, this space is occupied by the resistances or the trailing-cable reel, or both. In many cases, a cab for the brakeman could be provided by shifting the positions of the reel and resistances; in others, the frame of the locomotive could be extended. In either case, no great tax would be imposed upon the ingenuity of the mechanics, and the cost of such changes would not be prohibitive. In dollars and cents, the cost of such a change would probably be much less than the charge for compensation if a brakeman were killed or seriously injured through the failure to provide a safe place for him to ride.

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BLOCKING OF CARS AND TRIPS

The failure to block or secure standing cars is responsible for many of the accidents attributed to haulage. Every standing car and every trip of standing cars should be secured effectively, regardless of the grade. Grades are deceptive to the eye, and even a slight grade may be steep enough to cause a car or trip to run away and injure someone.

Several means of securing standing cars have been devised, among them being safety chains, clevises, and car-blocks attached to the rails; all of them are fairly effective when used properly. In addition, some mine cars are equipped with brakes, which usually are effective if kept in repair. When safety chains are used, the chains and fastenings should be of ample strength to withstand the load imposed upon them. They should not be subjected to sudden undue strain, such as permitting them to stop trips; they should be adjusted so that relatively little slack is permitted when they are fastened to a car; and they should be inspected frequently for flaws or defects.

When a clevis is used, it should, if possible, be placed in approximately the proper location before the car or cars are delivered. It should be of ample strength and of a design that will permit its use with a minimum of exposure to moving wheels. The car should come to a complete standstill before any attempt is made to fasten the clevis to the wheel.

A car block should be fastened securely to the track and be of a type that will permit it to be placed and removed without danger to the person handling it and also with minimum damage to the car. Preferably, a car block should be placed between the wheels, in such manner that it will prevent the car from traveling inadvertently in either direction. In some haulage installations wooden props can be used to advantage.

RETRACKING DERAILED EQUIPMENT

In many cases, little consideration is given to the possibility of derailments when the mine cars are designed. Many of the later-type mine cars are built so that the beds are within an inch or two of the rails when the cars are on the track; the wheels of these cars are usually 12 to 14 inches in diameter and are installed in pockets where they are practically invisible from the sides and ends of the car. When such a car is derailed, it is practically impossible to use the standard types of rerailers. A lifting jack or the "stiff jack" must be utilized as devices for retracking the car. Most brakemen are unwilling to take the time necessary to rerail a car with a lifting jack; therefore, unless rules to the contrary are enforced rigidly, they are likely to make use of a "stiff jack." It is quite true that some brakemen become proficient in the use of this device and that if it is used carefully there is little danger. However, its continued use induces carelessness, and it is detrimental to the track and is likely to cause accidents.

In some mines where low, box-type mine cars are used, the haulage crew is required to retrack only the equipment derailed on the haulageways; derailed cars in the working places are retracked by other workmen. The possibility of derailments should certainly be given careful consideration when mine cars are designed, as it is almost a certainty that derailments will occur, even where track and other conditions have been prepared and maintained to minimize the occurrence of derailments.

UNAUTHORIZED USE OF HAULAGE EQUIPMENT

Definite effort should be made to prevent the unauthorized use of haulage equipment.

Parked locomotives on the surface during idle periods are attractions, particularly to small boys who may be about; in a relatively recent case a child at a West Virginia mine was killed when a playmate crushed him between a locomotive and a trip of standing cars.

Workmen inside a mine are prone to use locomotives that are not attended or that are not being used on regular duty. This practice has caused numerous accidents, some of them resulting in death and a few in mine disasters. Fire bosses and other mine officials not expert in handling haulage equipment sometimes attempt to save time and labor while they are alone inside a mine, occasionally with serious results.

Contrary to instructions, a fire boss in West Virginia used a locomotive in the course of his mine inspection. He took the locomotive to the last crosscut in an entry that was known to be liberating methane, and a spark from the controller ignited gas that had accumulated back to the crosscut.

A fire boss at another West Virginia mine took a locomotive into an abandoned entry that was known to be liberating gas. A roof fall near the mouth of the entry had torn down a stopping, which short-circuited the air from the faces, and a spark from the trolley pole ignited gas that had accumulated for a distance of 200 feet outby the face. Fortunately, the area was well rock-dusted, and the ensuing explosion did not travel throughout the mine.

These two instances of West Virginia fire bosses causing explosions in wrongful use of trolley locomotives are by no means the only ones in which mine officials (including electricians) have caused explosions, fires, and other accidents by using haulage equipment at the wrong time or in a wrong manner.

TRANSPORTATION WITH SHUTTLE CARS AND CONVEYORS

In recent years, there has been a growing trend toward so-called trackless mining, particularly in the thinner coal beds. While many of the ordinary haulage hazards are reduced by this means of transportation, other hazards have been introduced, and the accident rate is high when one considers that comparatively few men are needed to operate the equipment.

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Brakemen are not needed in the face regions where shuttle cars are used; consequently, accidents in the coupling of cars are practically eliminated. The insecure blocking of standing cars is not a hazard, and the retracking of derailed equipment is not one of the sources of injury.

The most prolific source of injury during shuttle-car haulage is falling roof, when the latter should be supported from a place near the ribs. Obviously, posts cannot be set near the center line of an ordinary-width entry; and, when the roof is weak, it must be supported by means of cross bars set on posts alongside the roadways. Because of the shortage of timbers in some areas and their cost when they are available, cross bars are usually cut to the shortest possible length that will permit the passage of equipment between the posts supporting them; thus, there is the ever-present possibility of posts being dislodged, permitting the roof to fall. Depending upon the skill of the shuttle-car operator, a shuttle car travels on a fairly straight course, except on curves and turn-outs. Nevertheless, ample clearance should be provided between the shuttle cars and the roadway posts. Even in mines where the roof is fairly sound and there is relatively little danger from falling roof when posts are dislodged, many shuttle car operators are injured by being crushed between the shuttle cars and the posts and some by falling roof material or by falling timber cross bars.

Generally, the wheel base of shuttle cars is greater than that of locomotives and cars; consequently, more space between opposite rows of roadway posts is necessary, especially on curves and turn-outs, in order that the shuttle cars may be operated safely and efficiently. Either longer and stronger cross bars or the removal of loose roof will be necessary; if cross bars are used, the supporting posts should be recessed into the ribs or otherwise protected against dislodgment.

Shuttle cars, particularly those operated by means of storage batteries, are comparatively noiseless in operation. When they are being operated in the vicinity of other equipment, their approach can easily be unnoticed by the workmen. Every shuttle car should be equipped with an efficient headlight on each end and also with an effective, audible warning device. In addition, either shelter holes at frequent intervals or ample clearance between the posts and ribs should be provided as the workings are advanced.

Poor face ventilation in shuttle-car sections is not unusual, particularly when the section comprises developing headings, which generally are advanced rapidly, often by multiple shifts, and check curtains are employed frequently in lieu of permanent stoppings and doors. It is difficult to keep these curtains in anything like leakproof condition; as a consequence, ventilation of the working faces is often inefficient and results in accumulations of gas. While this may not appear to be a haulage hazard, it certainly is one caused largely by the haulage system, and the life of every person in the mine may be endangered because of it.

Transporting supplies on chain-and-flight conveyors is a common source of injury. Men should not be permitted to stand astride the conveyor line while loading or unloading supplies, and they should always handle the object being transported from the end opposite the direction of travel.

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TRANSPORTATION OF MEN

Generally, the greatest concentration of men in coal mines is in the man-trips or at the man-trip stations. It is not unusual for as many as 150 men to be riding together in the same man-trip; obviously, more than ordinary precautions should be taken to prevent accidents of disaster proportions where large groups of men are assembled.

The roof at the man-trip stations and over the haulageways where the man-trips are required to travel should be inspected carefully and frequently. A roof fall on a man-trip in Ohio killed three men and injured nine others, and similar accidents have occurred elsewhere with heavier loss of life.

The couplings between cars in man-trips should be inspected before the trip is loaded, and it is advisable that a locomotive be attached to each end of every man-trip, regardless of grades. Because of a broken coupling in a man-trip in Virginia, part of the trip became detached, the cars ran away, and eight men were injured.

Every precaution should be taken to prevent runaway cars or trips from crashing into a man-trip. Standing cars and trips of cars should be well-secured, and a derail should be installed at each end of every sidetrack. A safety chain securing 12 loaded cars on a surface sidetrack in West Virginia became broken; and, because a derail was not installed at the end of the sidetrack, these cars ran out onto the main line and crashed into a man-trip, killing two men and injuring nine others.

Much effort should be made to insure that orders are understood clearly before a man-trip is permitted to operate. A substation operator in an Illinois mine was instructed by telephone to stop a man-trip as it passed near the substation. The instructions were not carried out; and three men were killed, four were injured seriously, and twelve received minor injuries. The substation operator stated that the telephone had not been in good working condition and that the instructions to stop the trip had not been understood.

The transportation of men on belt conveyors also introduces hazards. Ample overhead clearance and adequate illumination should be provided along belt lines and at the man-trip stations. Stop-controls should be installed at each man-trip station, and an attendant should be on duty at each station while men are riding on the belts. In addition, means of signaling these attendants or of stopping the belt should be installed either continuously or at frequent intervals along the belt line.

The speed of a belt should not exceed 250 feet a minute while men are loading, unloading, or riding on the belt, and men on the belt should be spaced at least 5 feet apart. Tools or supplies should not be transported on a belt while it is carrying men.

The roof at man-trip stations along belt lines should be at least 4 feet above the top of the belt, and a bridge should be provided at each place where men are required to cross over a moving belt.

Men should not ride on chain-type conveyors at any time.

HAULAGE IN SHAFTS AND ON INCLINES

Only a few hazards to employees are presented by the hoisting of coal in shafts. When ample clearance, adequate illumination, and a suitable passageway from one side of the shaft to the other are provided at the shaft bottom, and when the employees observe reasonable rules of conduct, there is relatively little likelihood of personal injury to those employees. Only those men whose duties require them to be in the immediate vicinity of the shaft bottom should be permitted near the shaft while coal is being hoisted. A safe waiting place near the shaft should be provided for men waiting to leave the mine, and other activities in the vicinity of each shaft landing should cease while men are being handled.

The hoisting engine at every shaft where men are hoisted should be equipped with automatic devices to prevent excessive speeds and the hoisting of men above the regular landing places. There are records of several instances where hoisting engineers became suddenly incapacitated while hoisting men, and passengers on the cage were killed or injured.

The rope attachments to the cage, the safety catches, and the automatic devices on the hoisting engine should be inspected every day, and the effectiveness of the safety catches should be tested at frequent intervals. A falling cage at a mine in a large coal-producing State killed five men in 1922. The overwind device on a hoist in Illinois was not set properly for hoisting men, and the hoisting engineer accidentally pulled the cage into the dump.

Every cage used for handling men should be well-constructed, with enclosed sides and the top covered entirely by a steel bonnet; and the ends should be protected by gates, which should be closed at all times when men are on the cage. Suitable handholds should be provided for men riding on the cages, and the cages should not be crowded.

The surface landings of shafts should be enclosed for at least 6 feet above the ground level, the gates should be installed so that they cannot be opened unless the cage is at the landing, and the gates should close automatically when the cage is moved from the landing; the gates should be so constructed that materials cannot roll under them from the landing and into the shaft. Men should load onto the cage in an orderly manner. To make this precaution effective, many shaft landings are so arranged that men must approach and leave the landings in single file.

An attendant should be on duty at each landing while man-trips are being handled in the shaft. These attendants should supervise the loading and unloading of men and transmit all signals to the hoist operator, and they should have authority to discipline persons who willfully ignore the adopted safety rules pertaining to the handling of men in shafts.

Most of the safety rules governing the operation of man-trips in shafts apply, also, to man-trips on inclines; the hoisting equipment, ropes and rope connections, and the man cars should be subjected to the same critical inspections, and the loading and unloading of men should be supervised just as carefully. Five men were killed in 1942 when a man-trip on a West Virginia incline broke loose from its fastenings.

The man-car on an incline should be well-constructed, with level seats and handholds, and it should not be overloaded. Some man-cars are built with a shield at the top end to protect the passengers from stones or other objects that may roll down the incline.

The practicability of a drag attached to the rear of a man-car on a steep incline is debatable. However, some man-cars are equipped with drags longer than the man-car and attached to each side of the car near its uphill end. Such drags are connected to the hoisting rope in such a way that they will become operative if the rope should break and the tension on the rope is relieved. During tests with an empty man-car on a 38° incline in West Virginia, it was reported that the man-car was stopped within 4 feet by such a device.

Well-designed signaling devices are as essential in the operation of man-trips on surface inclines as they are in shafts. Natural obstructions, fog, and the darkness of night may prevent the use of hand signals; and such signals, if seen by the hoisting engineer, may be misconstrued.

All track approaches to steep parts of an incline should be guarded by derails and stop blocks. These derails and stop blocks should be of a design that must be closed manually and will become operative automatically when released. In some cases the incline used for handling man-trips is not used for any other purpose, and its track is not connected with other tracks.

CONCLUSIONS

A study of the causes of haulage accidents in and about coal mines indicates that most of these accidents are preventable. When both management and labor shall have accepted this fact, a great stride toward eliminating haulage accidents will have been made. When management removes all the physical hazards within its power and when the supervisory officials cease to "wink" at violations of the safety rules because of temporary conditions and when the workers cease to take chances which they know (or at least should know) are hazardous, then, and only then, can we expect a satisfactory reduction in the number of haulage accidents. Workmen in general are likely to follow the example set by the supervisors in observing safety rules.

Supervisors should neither encourage nor condone even the most trivial violation of the safe-haulage rules, and the latter should be well thought-out, reasonable and feasible.

Most safety engineers agree that, when an employee violates a well-known safety rule for the first time, he is not likely to be injured; the same may be true for the second or third times; it is when such violations become habitual that accidents occur. Therefore, well-maintained haulage equipment, well-maintained track, and sensible rules of conduct strictly adhered to seem to be the essential components of an accident-free haulage system or at least one in which accidents are held to a minimum, both as to frequency and as to severity.